REMARKS

Claims 1-5, 8, 10-16 and 18-19 are pending in this application. The Office Action objects to claims 1 and 3; rejects claims 1-5 and 8-17 under 35 U.S.C. §112, first paragraph; rejects claims 1-5 and 8-17 under 35 U.S.C. §112, second paragraph; and rejects claims 1-5 and 8-17 are rejected under 35 U.S.C. §103(a). By this Amendment, claims 1, 8, 10 and 12-15 are amended; claims 9 and 17 are cancelled; and new claims 18 and 19 are added. Support for the amendments to claim 1 may be found in original claims 9 and 17; all other claims are amended for mere formalities; support for new claims 18 and 19 may be found in the present specification at, for example, page 20, line 32 to page 21, line 22. No new matter is added.

I. Claim Objections

A. Claim 1

Claim 1 is objected to because the term "metal material article *having electrical conductivity*" allegedly lacks antecedent basis.

Without admitting the propriety of the rejection, and in the interest of advancing prosecution, claim 1 is amended to only recite "a metal article" and "said metal article."

Reconsideration and withdrawal of the objection are respectfully requested.

B. Claim 3

The objection to claim 3 made in the Office Action mailed September 28, 2007 was withdrawn by the Advisory Action mailed April 9, 2008.

II Rejections under 35 U.S.C. §112

A. Claims 1-5 and 8-17 under 35 U.S.C. §112, first paragraph

The rejection of claims 1-5 and 8-17 under 35 U.S.C. §112, first paragraph made in the Office Action mailed September 28, 2007 was withdrawn by the Advisory Action mailed April 9, 2008.

B. Claims 1-5 and 8-17 under 35 U.S.C. §112, second paragraph

Claims 1-5 and 8-17 are rejected under 35 U.S.C. §112, second paragraph as allegedly being indefinite.

Applicants note that the rejections regarding claim 1, line 16; claim 2, lines 3-4; and claims 3-5, 9, 13-14 and 17 under 35 U.S.C. §112, second paragraph, were withdrawn by the Advisory Action mailed April 9, 2008.

Accordingly, only claims 1-2 and 8 remain rejected under 35 U.S.C. §112, second paragraph, for allegedly being indefinite.

1. Claim 1

With regards to claim 1, line 18, "a metal material article to be treated of a steel material," Applicants respectfully traverse the rejection. (All references to claim line numbers are with respect to the claims as presented in the Amendment After Final Rejection filed March 28, 2008, *not* with respect to the currently amended claims, in order to accord with the notation used in the Advisory Action.)

Applicants respectfully submit that this language means that when the electrode is Fe and the metal material to be treated is a steel material, Fe ions can be dissolved into the treatment bath from both the electrode and the steel material. On the other hand, when the electrode is a material other than Fe and the metal material to be treated is a steel material, Fe ions can be dissolved into the treatment bath from only the steel material.

With regards to claim 1, lines 12-13, "a hydrogen standard electrode potential" and line 24 "the hydrogen standard electrode," claim 1 is hereby amended such that line 24 recites "the hydrogen standard electrode *potential*."

2. Claim 2

With regard to claim 2, lines 2-3, "an electrode material that dissolved in the treatment bath," Applicants respectfully traverse the rejection. Applicants respectfully submit that "an

electrode material" in claim 2 is not limited to a Fe electrode because the electrode in claim 1 is not limited to a Fe electrode.

3. Claim 8

With regard to claim 8, line 2, "the metal ions that form a complex with the phosphoric acid," claim 8 is hereby amended to recite " the metal ions that form a complex with ~~the phosphoric acid and~~ the phosphate ions" in accordance with claim 1.

4. Claim 17

Applicants note that a new rejection under 35 U.S.C. §112, second paragraph, was made in the Advisory Action on page 12. By this Amendment, claim 17 is cancelled. To the extent that independent claim 1 has been amended to incorporate the features of claim 17, the allegedly indefinite language has been changed.

Reconsideration and withdrawal of the rejections are respectfully requested

III. Rejections under 35 U.S.C. §103(a)

Claims 1-5 and 8-17 are rejected under 35 U.S.C. §103(a) as having been obvious over EP 1,074,640 A1 ("'640") in view of Matsuda (U.S. Patent No. 5,645,706). Applicants respectfully traverse the rejection.

Matsuda (US '706) relates to a method for an electrolytic treatment of an electroconductive material in a phosphate chemical treatment bath. However, the phosphate chemical treatment bath is not different from that used in a conventional non-electrolytic method (i.e. a non-electrolytic bath). Such a non-electrolytic bath is always maintained in an activated state by replenishing chemicals such as an accelerator.

Matsuda (US '706) discloses the phosphate chemical treatment bath as follows: "The presently claimed invention is limited only to soluble components (H_3PO_4, NO_3^-, HNO_2, metal ions such as Zn^{2+}, etc.) with no sludge, in chemical treatment baths, and the substance to be treated and the electrode are placed in the treatment bath and an external power source

connected between them, thus applying an electrical current between the substance to be treated (work-piece) and the electrode. Further, the phosphate chemical treatment bath is controlled so that sludge is not produced therein." Column 7, lines 34 to 38. Additionally, "raising of the pH is accomplished by introducing a chemical such as caustic soda which will shift the treatment bath towards the alkaline end." Column 14, lines 29 to 31.

It is easily assumed on the basis of the examples that Matsuda uses a conventional non-electrolytic treatment bath. In all the Examples, an accelerator (i.e. an oxidation accelerator such as sodium nitrite) is used and accelerator concentration is set out.

Thus, Matsuda discloses that the phosphate chemical treatment bath contains soluble metal ions such as Na^+ derived from sodium nitrite and caustic soda.

Matsuda conducts an electrolytic treatment using a conventional non-electrolytic treatment bath. In the case of forming a film by the electrolytic treatment, it is necessary to avoid sludge in the treatment bath. Matsuda discloses that sludge is removed from a treatment bath. This reason is because sludge is unavoidably formed in a conventional non-electrolytic treatment bath.

On the other hand, both of the presently claimed invention and EP '640 relate to a method for an electrolytic treatment of an electroconductive material using an *electrolytic treatment bath*.

A phosphate chemical treatment bath in the presently claimed invention and EP '640 is substantially free of metal ions other than those which are a component of a film to be formed (i.e. 0 - 400 ppm), on the surface of a metal material article to be treated. Accordingly, the activation of the electrolytic treatment bath is based on only an electrolytic energy (without active chemicals such as sodium nitrite) and hence the degree of activation can promptly be controlled.

Although EP '640 'refers to "unavoidably formed reaction products (sludge) and nitrides (such as NO_2) by reduction of nitrate ion other than... can be removed from the treatment bath," it fails to disclose the constituent feature of the presently claimed invention that makes it possible to conduct an electrolytic treatment of an electroconductive material continuously for a long time period.

Thus, EP '640 fails to control the amount of substance harmful to the reaction, generated in the electrolytic phosphate chemical treatment reaction. In the presently claimed invention, the substance harmful to the reaction, such as (a) excess Fe ions, (b) N_2O_4 generated from the reduction of nitrate ions, is removed from the treatment bath so as to obtain a stable treatment bath.

Regarding the removal of N_2O_4

N_2O_4 cannot be removed from the solution due to a mere contact with an atmosphere because it has a high boiling point, while NO gas having a low boiling point can easily be removed. Table 3 of the present specification shows the boiling points of N_2O_4 (29.07°C). Thus, EP '640 fails to teach a specific means to remove N_2O_4.

In the presently claimed invention, the reduction of nitrate ions proceeds as follows.

$NO_3^- + 4H^+ + 3e \longrightarrow NO + 2H_20$:960mV {12)

$NO_3 + 2H^+ + e \longrightarrow 1/2N_20_4 + H_2O$: 800mV (13)

$NO_3^- + 2H^+ + 2e \longrightarrow NO_2 + H_2O$:840mV (19)

The reaction according to (13) occurs when the ORP of the treatment bath is 800mV or less. Thus, N_2O_4 does not generate when the ORP of the treatment bath is greater than 800mV.

The ORP of the treatment bath can be controlled in the light of the N_2O_4 generation, and the generated N_2O_4 can be removed using the presently claimed invention.

If N_2O_4 is not removed from the treatment bath, dissolved $N2O_4$ prevents ions from moving so that an insufficient electroconductivity is induced in an electrolytic treatment.

Regarding the control of Fe ions (suppressing the amount of Fe ions)

Fe ions are dissolved in the treatment bath, when a steel material is used as an article to be treated and when an Fe electrode is used for a film forming metal electrode in the electrolytic chemical treatment. Chemicals containing Fe can be added to the treatment bath, if necessary.

The dissolution of Fe proceeds in the manner of $Fe \rightarrow Fe^{2+} \rightarrow Fe^{3+}$, and hence Fe exists as Fe^{2+} or Fe^{3+} ions.

a) $Fe \rightarrow Fe^{2+} + e$: -
b) $Fe^{2+} \rightarrow Fe^{3+} + e$: 770mV

Thus, Fe dissolves, as Fe^{3+} ions, in the treatment bath having the ORP of 770mV or higher. Further, the solubility of Fe depends on the state of Fe ions, and it is well-known that the solubility of Fe^{2+} is larger than that of Fe^{3+}. Accordingly, if the ORP less than 770mV of the treatment bath having Fe^{2+} ions increases to the ORP of 770mV or higher, sludge forms in the treatment bath since the solubility of Fe ions decreases. According to the increase in the dissolved Fe ions, the ORP of the treatment bath is convergent to the equilibrium electrode potential, i.e. 770mV, and thereby sludge forms in the treatment bath.

Dissolution of Fe is inevitable as long as a steel material or an Fe electrode is used. However, the amount of the dissolved Fe ions can be suppressed by controlling the voltage and current applied so that Fe ions in the treatment bath exists under the concentration in which Fe^{3+} ions dissolve (the ORP is 770mV or greater).

Regarding Matsuda, the Office Action alleges that "since Fe^{3+} is stably present in the bath with an ORP of 560mV or greater..." (Office Action, col.13, lines 39-58). However, Matsuda relates to a conventional non-electrolytic treatment bath in which sludge is unavoidably formed.

On the other hand, the presently claimed invention relates to an electrolytic treatment bath in which sludge is not inherently formed. The presently claimed invention is made based on the finding that a large amount of Fe ions induces the formation of sludge even in the electrolytic treatment bath,

Regarding pH and ORP values

In a non-electrolytic treatment, it is important to control pH and ORP values so that electrochemical conditions of a treatment bath are properly designated. However, it is impossible to measure and control the pH and ORP values in a heated treatment bath, which is commonly used for a non-electrolytic treatment, because existing ions in the treatment bath are always decomposed due to heat and ions are unstable.

US 4,565,585 (to Mr. Matsuda, who is one of the inventors of the presently claimed invention) discloses a method for a non-electrolytic treatment in which the temperature of a treatment bath is maintained within the range of from 0 to 40°C and pH 2.2-3.5 and ORP of 0-700 mV therein are maintained (claim I). In US '585, a steel material is treated and hence energy provided it the treatment bath is based on dissolution of the steel material ($Fe \rightarrow Fe^{2+} + 2e$:

-440mV). The ORP of 0-700 mV is selected so as to promote dissolution of the steel material. On the other hand, pH 2.2-3.5 is selected to promote the formation of a film on the steel material.

Matsuda uses a conventional non-electrolytic bath, as mentioned above. Therefore, the pH and ORP values therein (pH 2-4 and ORP of 460-860 mV) are not basically different from that in US '585. Although the ORP value in Matsuda is higher than that in US '585, the difference is caused by an electrolytic treatment which provides a larger energy than non-electrolytic treatment.

EP '640 relates to a method using an electrolytic bath and hence the preferable pH range is 0.5-5 (paragraph [0218]). The OR is based on Table 4 showing the reaction formulas that are involved in electrolytic phosphate chemical treatment (paragraph [0219]). In the presently claimed invention, the ORP and pH values are further restricted. The ORP of 770 to 960mV depends on the reaction formulas (3) and (12). The pH of 2.5 or lower is effective against the N_2O_4 generation.

Accordingly, independent claim 1 would not have been obvious over the applied references for at least the reasons discussed above. Dependent claims 2-5, 8 and 10-16 therefore also would not have been obvious for at least the reason that independent claim 1 would not have been obvious. Dependent claims 9 and 17 are cancelled.

Reconsideration and withdrawal of the rejection are respectfully requested.

IV. Conclusion

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of the application are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,

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Enclosures:
Request for Continued Examination
Petition for Extension of Time

Date: October 28, 2008

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